Ultra-Long Duration Balloon Control Center Requirements and Functional Specifications

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Signature Page

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Change Information Page

Version	Date	Description	Affected Pages
1.0	08/03/98	Original.	All
2.0	08/11/98	Reorganization of functional areas.	All
2.1	09/21/98	Updated following project review.	All
2.2	10/02/98	Data format requirements changed.	All

Table of Contents

1.0 Introduction

Recent advances in composite super-pressure balloon materials have greatly enhanced the prospects for very long duration balloon flights on Earth as well as possible use for planetary exploration. NASA is embarking on the development of technologies to support extended balloon missions lasting up to 100 days (~5 circumnavigations of the globe) above 99.9% of Earth's atmosphere.

The Ultra Long Duration Balloon (ULDB) objective is to develop a low cost, integrated, advanced, long duration balloon system which is technically feasible and within program cost constraints while maintaining the existing balloon program. The ULDB program is significantly different from the current balloon program in that the expected science return is significantly greater than current balloon missions. In other words, it is more than simply extending current experiments over a longer time period. This program also expects to use technologies currently available in the spacecraft missions and commercial arenas to improve performance while containing costs.

The purpose of the ULDB Control Center software effort is to provide ULDB scientists, engineers, and mission operators with software tools with which they can monitor the status of and issue commands to ULDB instruments. The control center systems will support integration, pre-launch checkout, launch, float, and terminate operations.

1.1 Purpose

The document describes the ULDB Control Center requirements and functional specifications. It is intended to include a complete list of all the requirements in all of the functional areas for all ULDB Control Center systems. It is expected that this document shall be the basis from which design decisions will be made.

1.2 Applicable Documents

1.2.1 Project Documentation

The following ULDB project documentation is applicable and/or related to this document.

ULDB Design-To Requirements Document, revision 1.2, December 3, 1997,
http://www.wff.nasa.gov/~uldb/designreqmts.pdf

1.2.2 Subsystem Documentation

The following ULDB Control Center specific documentation is applicable and/or related to this document. These documents are available via the ULDB Control Center page:
http://www.wff.nasa.gov/~code584/ULDBControlCenter/index.html.

ULDB Control Center Product Plan
ULDB Control Center Software Development Management Plan
ULDB Control Center Operations Concept

2.0 System Overview

The ULDB Control Center will include several systems that are designed to coordinate communication between scientists, engineers, and operations personnel and the balloon-craft and science instruments. A fixed computer-based data handling and processing system will be provided to support float and terminate operations. This system will be placed in the ULDB Operations Control Center and shall be referred to as the Operations Control Center (OCC). A portable computer-based data handling and processing system shall be provided to support integration, pre-launch checkout, launch, float, and terminate operations. This portable system shall be referred to as the Remote Operations Control Center (ROCC). A computer-based software system shall be provided to monitor balloon-craft and science instruments and provide limited

control of those instruments. This system shall be referred to as the Remote Monitor and Control System (RMCS).

3.0 OCC Requirements and Functional Specifications

Six OCC functional areas have been defined to support ULDB operations. The defined functional areas may represent individual subsystems in the physical control center implementation, or may be combined into one or more physical subsystems. The functional areas are General System, Telemetry Acquisition, Command, Data Management, Real-time Monitor and Control, and Data Analysis.

3.1 General System Functions

This section specifies the ULDB general system functions that are allocated to the Operations Control Center. The communication interfaces, integration and test, performance, external interface, security and hardware requirements will be included in this section.

3.1.1 Communication Interfaces

This section specifies the OCC communication interface requirements.

OCC-GEN-00111	The OCC shall use and support the Space Network (SN) to obtain forward and return link data communications.
OCC-GEN-00120	The OCC shall use and support the INMARSAT network to obtain forward and return link data communications.
OCC-GEN-00130	The OCC shall use and support the Iridium network to obtain forward and return link data communications.
OCC-GEN-00140	The OCC shall use and support the ARGOS network to obtain return link data communications.

3.1.2 Integration and Test

OCC-GEN-00210	The OCC shall support instrument integration and test activities associated with the balloon-craft prior to launch.

3.1.3 Performance

System-level performance requirements are specified in this section, including capacities, capabilities, and throughput.

OCC-GEN-00310	The OCC shall relay a command from the user to the uplink interface within 1.0 second.
OCC-GEN-00320	The OCC shall support simultaneous monitoring and commanding of ULDB balloon-craft.

3.1.4 External Interfaces

OCC external interfaces refer to the interfaces between the OCC and various, supporting elements, NASA institutional facilities, and Principal Investigator (PI) sites.

OCC-GEN-00410	The OCC shall provide a near real-time interface to the PIs for forwarding of all science data and receipt of science instrument commands.

OCC-GEN-00420 OCC external interfaces shall conform to all security requirements specified in Section 3.1.5.

OCC-GEN-00431 The OCC shall provide an Internet interface for the display of balloon-craft engineering parameters.

OCC-GEN-00441 The OCC shall utilize the same Space Network Mission Planning Terminal (MPT) for scheduling of SN resources as it used by the Long Duration Balloon (LDB) Program.

3.1.5 Security

This section specifies the overall OCC security requirements.

OCC-GEN-00510 The OCC shall require unique sessions for each operator that accesses OCC resources.

OCC-GEN-00520 The OCC shall require a unique user identification and password for each individual user.

OCC-GEN-00530 The OCC shall be able to perform filtering based on network address and/or TCP/IP socket number to control external interfaces.

OCC-GEN-00540 The OCC shall provide a secure means of receiving science payload commands from PIs.

3.1.6 Hardware

This section defines the specification level requirements for the OCC hardware. The OCC will consist of one real-time server, one analysis server, and one fully configured backup server that is capable of providing all of the functionality of either the real-time or analysis server. An external interface server will operate as the interface to the PIs, the RMCS, and the World Wide Web.

3.1.6.1 Real-time Server

The OCC will provide processors and peripheral equipment necessary for processing balloon-craft telemetry and commands.

OCC-GEN-01610 The real-time server shall be physically and functionally identical to the analysis server and backup server.

OCC-GEN-01620 The real-time server shall include a dedicated workstation to be used as the local systems operations console.

OCC-GEN-01630 The real-time server shall be upgradeable/expandable with additional quantities and types of peripherals.

OCC-GEN-01641 The real-time server disk drives shall provide a minimum of 54 GB of storage.

OCC-GEN-01650 The real-time server shall support one CD-ROM drive.

3.1.6.2 Analysis Server

A user station will be provided to support OCC analysis functions.

OCC-GEN-02610 The analysis server shall conform to all real-time server requirements as stated in Section 3.1.6.1.

3.1.6.3 Backup Server

A backup server will be provided that may function as either the real-time server or analysis server in the event of a failure in either prime system.

OCC-GEN-03610 The backup server shall conform to all real-time and analysis server requirements as stated in Sections 3.1.6.1 and 3.1.6.2, respectively.

3.1.6.4 External Interface Server

An external interface server will be provided to act as the interface to entities receiving data from or sending commands to any of the other OCC servers.

OCC-GEN-04610 A server shall be provided to act as the external interface to the OCC.

3.1.6.5 Data Storage Unit

A data storage unit will be provided to store all incoming ULDB mission data.

OCC-GEN-05611 The OCC shall provide the capability to store a minimum of 54 GB of data per ULDB mission.

3.1.6.6 System Peripherals

The following peripheral devices will be supplied to support OCC operations.

OCC-GEN-06610 All OCC real-time, analysis, and backup servers shall have monitors with a minimum diagonal measurement of 19 inches.

OCC-GEN-06620 A shared system printer shall be provided that is accessible from the real-time, analysis, and backup servers.

3.2 Telemetry Acquisition Functions

The OCC will provide the capability to receive, process, and monitor telemetry data from the balloon-craft. The real time telemetry function will accept CCSDS Transfer Frames (TBD), extract the CCSDS packets (TBD) from the transfer frames, and process those packets whose application identifiers are specified in the Project Data Base. All packets, regardless of application identifier, will be stored by the data storage function. Packets whose application identifiers indicate them to be science data or science housekeeping data will be forwarded without further processing to the instrument PI(s).

3.2.1 Telemetry Delivery

The OCC will be able to receive and process telemetry from the balloon-craft and OCC accessible telemetry archives.

3.2.1.1 Accept Telemetry Data

The OCC will accept balloon-craft telemetry from multiple telemetry sources.

OCC-TLM-01111 The OCC shall be capable of receiving ULDB balloon-craft and instrument telemetry using the Space Network (SN) communications service.

OCC-TLM-01120 The OCC shall be capable of receiving ULDB balloon-craft and instrument telemetry using the INMARSAT communications service.

OCC-TLM-01130 The OCC shall be capable of receiving ULDB balloon-craft and instrument telemetry using the ARGOS communications service.

OCC-TLM-01140 The OCC shall be capable of receiving ULDB balloon-craft and instrument telemetry using Iridium communications service.

OCC-TLM-01150 The OCC shall be capable of receiving archived balloon-craft telemetry.

3.2.1.2 Process CCSDS Transfer Frames

The OCC will extract CCSDS standard source telemetry data packets from CCSDS Transfer Frames and distribute them for processing.

OCC-TLM-02110 The OCC shall accept CCSDS Transfer Frames containing balloon-craft and instrument telemetry data.

3.2.2 Telemetry Packet Processing

The OCC will process CCSDS telemetry packets that have been extracted from transfer frames. The OCC packet processing includes determining the proper sequence of the received packets and extracting the packet data fields required for further telemetry processing.

OCC-TLM-00210 The OCC shall accept a CCSDS Version-1 format

OCC-TLM-00220 The OCC shall append a ground receipt date and time identifier to all received data.

OCC-TLM-00230 Science instrument housekeeping and science telemetry data will be forwarded to the specified PI location.

OCC-TLM-00240 The OCC shall perform subsequent processing functions only balloon-craft housekeeping data.

Note: Subsequent requirements in this section refer to balloon-craft housekeeping data unless otherwise specified.

OCC-TLM-00250 The OCC shall examine the CCSDS packet sequence count located within the primary header to determine a proper packet sequence and to detect missing packets.

OCC-TLM-00260 The OCC shall process balloon-craft housekeeping telemetry based on predefined configuration-specific processing algorithms.

OCC-TLM-00270 The OCC shall be capable of continuously processing balloon-craft housekeeping telemetry at rates of at least 50 Kbps and up to 150 Kbps.

OCC-TLM-00280 The OCC shall provide for the conversion of balloon-craft housekeeping telemetry into Engineering Units (EUs).

OCC-TLM-00290 The OCC shall store all processed telemetry in TBD format indefinitely.

3.2.2.1 Limit Checking

The OCC will have the capability of delta value checking any processed telemetry. A delta value is the maximum change expected between successive samples of a parameter. Delta values are defined in the telemetry database on an individual telemetry point basis.

The OCC will also have the capability to apply range checking to analog and discrete parameters using up to four groups of red and yellow high/low limit values obtained from the telemetry data base. Range checking may be performed on raw or EU-converted values whenever range limits have been defined in the Project Data Base.

OCC-TLM-01210	The OCC shall perform high/low limit checking on parameters when limits have been defined.
OCC-TLM-01220	The OCC shall have the capability to limit check parameters for red high, red low, yellow high, and yellow low boundary violations.
OCC-TLM-01230	The OCC shall limit check telemetry data against its associated limit values for every occurrence of the parameter.
OCC-TLM-01240	The OCC shall compare the change of successive raw parameter values with the predefined delta value.
OCC-TLM-01250	The OCC shall mark each telemetry parameter indicating the current limit condition.

3.2.2.2 Limit Condition Reporting

A limit condition change notification is generated each time a parameter crosses a limit threshold value (when it exceeds a limit or when it comes back within a limit). A change in limit state may cause a notification to be output for display and/or logging. Notification is also provided during the time a parameter remains out of limits.

OCC-TLM-02210	The OCC shall notify the user when a parameter violates high/low limits.
OCC-TLM-02220	The OCC shall notify the user when a parameter returns to within high/low limits.
OCC-TLM-02230	The OCC shall notify the user when a parameter incurs a delta limit violation.
OCC-TLM-02240	The OCC shall generate a notification without an alarm for limit violations in the yellow range.
OCC-TLM-02250	The OCC shall generate a notification with an alarm for limit violations in the red range. Note: An alarm reflects the severity of the violation and may trigger the display of highlighted text, an audible alarm, or both.
OCC-TLM-02260	The OCC shall provide the capability of disabling (suppressing) or enabling notification messages concerning limits for all parameters. Note: Although the display of notification messages may be suppressed, they will continue to be stored or logged.
OCC-TLM-02270	The OCC shall provide the user the capability of changing limit values, delta limit values, and limit sense intervals. Note: Changing of the limit values via user directive is temporary. Permanent alterations may be accommodated through changes in the limit values resident within the Project Data Base.

3.2.2.3 Convert to Engineering Units

The OCC provides the capability to convert processed telemetry data from raw counts to engineering units (EUs). Both raw and EU converted values will be accessible to the users.

OCC-TLM-03210 The OCC shall provide the capability for the user to select a predefined EU conversion algorithm.

OCC-TLM-03220 The OCC shall provide the capability for the user to adjust the predefined EU conversion algorithm coefficient values.

3.2.2.4 Access Processed Telemetry

The most recently processed value for each balloon-craft telemetry parameter is available for display and other application software access.

OCC-TLM-04210 The OCC shall make available the values for every predefined telemetry parameter.

OCC-TLM-04220 The OCC shall make available the status for every predefined telemetry parameter.

OCC-TLM-04230 The OCC shall make available, on a per-parameter basis, the following:
a. last processed raw value
b. associated converted value, if applicable
c. limit range values, if applicable
d. limit sense interval
e. no data available indicator
f. out of limits (low/high) indicators, if applicable
g. delta limit error indicator

3.2.2.5 Telemetry Displays

The OCC will be capable of displaying all balloon-craft housekeeping and other parameters required to support ULDB operations.

OCC-TLM-05210 The OCC shall provide the capability to display all balloon-craft housekeeping parameters as defined in the Project Data Base.

OCC-TLM-05220 The OCC shall be capable of displaying telemetry data from the active communications source in a single telemetry window with a pull-down menu for selecting which data is displayed.

OCC-TLM-05230 The OCC shall provide one or more top-level engineering displays that will include the following parameters and parameter units:
a. GPS latitude
b. GPS longitude
c. GPS altitude (feet)
a. Current balloon speed
b. Current balloon heading
d. Number of GPS satellites
e. MKS High Sensor (Primary) (mBars)
f. MKS High Sensor (Backup) (mBars)
g. MKS Mid Sensor (Primary) (mBars)
h. MKS Mid Sensor (Backup) (mBars)
i. Auto-Ballast Total for Today (seconds)
j. Load Cell (lbs)
k. Cumulative Ballast Drop Total (lbs)
l. BUS A Power (watts)
m. BUS B Power (watts)
n. Battery A Voltage (volts)

o. Battery A Current (amps)
p. Battery B Voltage (volts)
q. Battery B Current (amps)
r. PV A Power (watts)
s. PV B Power (watts)
t. Cryocooler BUS Power (watts)
u. Cryocooler PV Power (watts)
v. Cryocooler Battery Voltage (volts)
w. Cryocooler Battery Current (amps)
x. INMARSAT Antenna Temp (TDRSS TM) (degrees C)
y. Primary Terminate Stack Temp (degrees C)
z. Backup Terminate Stack Temp (degrees C)
aa. Parachute Cutaway Stack Temp (degrees C)
bb. TOP Stack Temp (degrees C)
cc. Command Count
dd. Graphic of balloon position over time
ee. Graphic of balloon altitude over time
ff. Graphic of temperature over time
gg. TBD additional parameters

OCC-TLM-05240 The OCC shall provide additional displays that together display all balloon-craft housekeeping parameters.

OCC-TLM-05250 The OCC shall provide an operations display that is capable of displaying select science instrument housekeeping parameters.

OCC-TLM-05260 The OCC shall provide an operations display that will include the following parameters:
a. Current balloon position
b. Current balloon altitude
c. Current ambient temperature
d. Current balloon speed
e. Current balloon heading
f. TBD voltages
g. TBD currents
h. Communications link status
i. TBD additional parameters

OCC-TLM-05271 The OCC shall provide a Web interface to make TBD engineering display parameters available to one or more Remote Monitor and Control Systems (RMCS) and other authorized users.

OCC-TLM-05281 The OCC shall provide a Web interface to make the top-level operations display available to one or more RMCS.

3.2.2.6 Telemetry Store and Replay

The OCC will have the capability of storing the down-linked raw telemetry. Stored telemetry may be replayed by specifying the data type and start and (optionally) stop time. Replay operations simulate real-time telemetry processing, including limit and delta limit checking, and will likewise permit the generation of derived parameters.

OCC-TLM-06210 The OCC shall store telemetry data as received from the data source (e.g., SN, INMARSAT, Iridium).

OCC-TLM-06220	The OCC shall be capable of receiving and storing real-time telemetry at rates of least 50 Kbps and up to 150 Kbps.
OCC-TLM-06230	The OCC shall be capable of receiving and storing balloon-craft recorder playback telemetry at rates of at least 50 Kbps and up to 150 Kbps.
OCC-TLM-06240	The OCC shall be capable of accepting and storing the down-linked balloon-craft or instrument computer memory dump.
OCC-TLM-06250	The OCC shall be capable of replaying telemetry data based upon a user specified time period.
OCC-TLM-06260	The OCC shall process all balloon-craft housekeeping telemetry data for the requested period during the replay operation.

3.2.2.7 Telemetry Forwarding

The OCC will have the capability to forward raw science data and raw science housekeeping data to PIs in near-real-time.

OCC-TLM-07210	The OCC shall provide an Internet-based interface capable of forwarding raw science data in near-real-time.
OCC-TLM-07220	The OCC shall provide an Internet-based interface capable of forwarding raw instrument housekeeping data in near-real-time.
OCC-TLM-07230	The OCC shall make available to PIs files containing processed balloon-craft housekeeping parameters for ftp pull.

3.3 Command Functions

The Command Function provides the capability to validate, build, up-link, and verify real-time commands for the ULDB balloon-craft and instruments.

3.3.1 Command Scripting

The OCC will provide tools used to manage the routine, planned operations of the ULDB missions. Planned operations are managed by means of scripts containing stored commands and/or data.

OCC-CMD-00110	The OCC shall be capable of receiving, validating, and forwarding commands from an approved source. Approved sources may include the PI and one or more RMCS.
OCC-CMD-00120	The OCC shall provide the capability to create, edit, and delete a script consisting of one or more commands.
OCC-CMD-00130	The OCC shall validate each field of each real-time command in a procedure.
OCC-CMD-00140	The OCC shall provide the capability to display a listing of scripts that have been generated or executed during the previous seven days.

3.3.2 Command Transmission Configurations

The OCC will have the capability to transmit commands to the ULDB balloon-craft and instruments using multiple interfaces.

OCC-CMD-00211 The OCC shall be capable of transmitting commands via the Space Network (SN).

OCC-CMD-00220 The OCC shall be capable of transmitting commands via the INMARSAT network.

OCC-CMD-00230 The OCC shall be capable of routing commands through the proper ocean region based on balloon location (GPS) when utilizing INMARSAT.

OCC-CMD-00240 The OCC shall be capable of transmitting commands via the Iridium network (TBD).

3.3.3 Command Types

The OCC will be capable of transmitting operator commands and command procedures.

OCC-CMD-00310 The OCC shall permit an authorized operator to issue individual commands in real-time.

OCC-CMD-00320 The OCC shall be capable of transmitting commands from a command procedure consisting of one or more commands.

OCC-CMD-00330 The OCC shall merge balloon-craft and instrument commands, and balloon-craft and instrument command procedures into one up-link stream.

3.3.4 Command Generation

OCC-CMD-00410 The OCC shall assemble standard, fixed-length packets from the command structures formatted for onboard execution.

OCC-CMD-00420 The OCC shall validate all real-time commands and ensure that the commands accepted conform to the command definition.

OCC-CMD-00430 The command set shall be flight configurable.

3.3.5 Pre-transmission Validations

The OCC will provide the capability to control the up-link of critical commands by requiring a second positive response from the operator. If a command procedure is being executed, confirmation is required for each critical command to be up-linked.

OCC-CMD-00510 The OCC shall determine a specific command as critical based on its definition in the Project Data Base.

OCC-CMD-00520 The OCC shall require an operator authorization (allow or cancel) prior to up-linking a critical command, regardless of its origin (operator input or command procedure).

3.3.6 Command Authorization

OCC-CMD-00610 The OCC shall verify prior to acceptance of a command that the command was issued from a user with command authority.

OCC-CMD-00620 The OCC shall verify prior to acceptance of a command that the operator issuing the command has authorization for that specific command.

3.3.7 Command Transmission

OCC-CMD-00710 The OCC shall archive all up-linked information in the format transmitted by the OCC with time tag.

OCC-CMD-00720 The OCC shall provide the capability to log each command based on the communications link through which it was sent.

OCC-CMD-00730 The OCC shall notify the operator when a command is transmitted.

OCC-CMD-00740 The OCC shall provide the capability to display the last command sent and a "button" to resend the last command sent, subject to additional operator authorization for critical commands.

OCC-CMD-00750 Mission critical commands shall take precedence over all other commands. Mission critical commands for each mission are defined in the Project Data Base.

OCC-CMD-00760 The OCC shall provide an interface through which operations personnel can prevent the instrument PI(s) from using any of the command up-links.

OCC-CMD-00770 The OCC shall alert operations personnel when instrument PIs are utilizing a particular communications up-link.

OCC-CMD-00780 The OCC shall automatically append the associated balloon ID number to all commands (including science commands) to ensure that all commands are sent to the proper balloon in the event that the OCC is supporting more than one concurrent mission.

3.3.8 Command Verification

Command receipt verification verifies that up-linked commands were received intact on board the balloon-craft.

OCC-CMD-00810 The OCC shall provide the capability to verify via COP-1 the successful receipt of real time commands by the balloon-craft.

OCC-CMD-00820 The OCC shall notify the operator of the status of each command up-linked as success or fail.

3.3.9 Command Displays

OCC-CMD-00910 The OCC shall be capable of displaying all commands as defined in the Project Data Base for each mission.

OCC-CMD-00920 The OCC shall display commands in a grouping according to command function.

OCC-CMD-00930 The OCC shall provide a macro facility (one command expanding to many) for frequently used sets of commands.

OCC-CMD-00940 The OCC shall display each command as it is selected.

OCC-CMD-00950 Alerts for critical command functions may be visual (color, background changes) or audible.

3.4 Data Management Functions

The Data Management function is responsible for supporting OCC mission operations, and is performed through four types of services: data base generation, file management, event processing, and ground telemetry generation.

3.4.1 Data Management

OCC-DAT-00110 The OCC shall display informational text messages about events that occur at the OCC and on the balloon-craft.

OCC-DAT-00120 The event display shall have a scrolling text field that displays the current event messages.

OCC-DAT-00130 The OCC shall provide the user with the capability to request and display event history data.

3.4.2 Project Data Base

The OCC will provide a Project Data Base (PDB) containing information necessary to support OCC mission operations. Telemetry, command, and constraint definitions will be maintained within a PDB for each mission. The input definitions will be loaded into the mission PDB where they may be edited, validated, and accessed for viewing. Once regarded as acceptable this information will be made available for operational use. The application software will use operational data to support telemetry processing and balloon-craft commanding.

3.4.2.1 PDB Inputs

The telemetry, command, and constraint definitions will be maintained within the PDB for each mission and will be used in support of ULDB mission operations.

OCC-DAT-01210 The OCC shall accept housekeeping telemetry definitions.

OCC-DAT-01220 The telemetry definitions shall contain the following information:

a. Telemetry data processing definitions
b. Discrete telemetry definitions
c. Discrete state definitions
d. Analog telemetry definitions
e. Red/yellow and delta limit definitions
f. Engineering unit conversion definitions
g. Derived parameter definitions
h. Subsystem/instrument definitions

OCC-DAT-01230 The OCC shall accept balloon-craft and instrument command definitions

OCC-DAT-01240 The command definitions shall contain the following information:

a. Balloon-craft command definitions
b. Instrument command definitions
c. Command criticality
d. Prerequisite state checking

3.4.2.2 PDB Edit

The OCC will provide an edit capability to allow additions, deletions, and modifications of the definitions maintained in the PDB.

OCC-DAT-02210 The OCC shall provide authorized users the capability to add, delete, and modify telemetry definitions.

OCC-DAT-02220 The OCC shall provide authorized users the capability to add, delete, and modify command definitions.

OCC-DAT-02230 The OCC shall provide a PDB edit log presenting edits made to the PDB.

OCC-DAT-02240 The OCC edit log shall include the following information:
a. Time stamp
b. PDB version number
c. File name
d. User ID
e. Changes made to the PDB since the last update

3.4.2.3 PDB Validation and Reporting

The OCC will provide validation of the definitions maintained in the PDB. Validation will include syntax checking, verification of values and cross-validation of related information.

OCC-DAT-03210 The OCC shall provide the capability to perform validation on the telemetry definitions maintained in the PDB.

OCC-DAT-03220 The OCC shall provide the capability to perform validation on the command definitions maintained in the PDB.

OCC-DAT-03230 The OCC shall provide the capability to perform validation on the constraint definitions maintained in the PDB.

OCC-DAT-03240 The OCC shall provide the capability to generate a validation report which contains summary and error information.

OCC-DAT-03250 The OCC shall provide authorized users the capability to report information maintained in the PDB.

3.4.2.4 PDB Backup, Restore, and Compare

OCC-DAT-04210 The OCC shall maintain all versions of the operational PDB.

OCC-DAT-04220 The OCC shall maintain the following information for each version of the PDB:
a. PDB version number
b. Effective date

OCC-DAT-04230 The OCC shall provide the capability to backup the operational PDB.

OCC-DAT-04240 The OCC shall provide the capability to restore the operational PDB.

OCC-DAT-04250 The OCC shall provide the capability to compare two versions of the validated PDB.

3.4.3 File Management

The OCC will provide the capability to archive and retrieve telemetry data, non-telemetry data, event data, and file data. All archived data will be maintained for a period of TBD days at the OCC.

3.4.3.1 Telemetry Archive

The OCC will provide the capability to archive and retrieve telemetry associated with each balloon-craft.

OCC-DAT-01310 The OCC shall archive all telemetry data.

OCC-DAT-01320 The OCC shall maintain the telemetry data on-line for a minimum of TBD days.

OCC-DAT-01330 The OCC shall provide the capability to retrieve archived data by specifying the following:
a. Balloon-craft start time
b. Balloon-craft stop time
c. Balloon-craft identifier
d. Data type

3.4.3.2 Events Archive

The OCC will be capable of archiving and retrieving events associated with each balloon-craft.

OCC-DAT-02310 The OCC shall archive all event messages.

OCC-DAT-02320 The OCC shall provide the capability to retrieve archived events by specifying the following:
a. Start time
b. Stop time
c. Event type
d. Event identifier
e. Balloon-craft identifier
f. Instrument identifier (if applicable)

3.4.3.3 File Archive

The OCC will be capable of storing, retrieving, and providing configuration control of data files in support of operations.

OCC-DAT-03310 The OCC shall be capable of storing and retrieving data files.

3.4.4 Event Message Processing

The OCC will process and display all event messages. The event message will be formatted to include a time tag, event type, event identifier, event message, balloon-craft identifier (if applicable), and instrument identifier (if applicable). The OCC provides the capability to set event filters, define event triggers, and toggle the alarm characteristic of an event.

OCC-DAT-00410 The OCC shall provide the capability to generate event messages.

OCC-DAT-00420 The OCC event messages shall include the following:
a. Time tag
b. Event type
c. Event identifier
d. Event message
e. Balloon-craft Identifier (if applicable)
f. Instrument Identifier (if applicable)

OCC-DAT-00430 The OCC shall provide the capability to filter event messages by:
a. Time tag
b. Event type
c. Event identifier
d. Balloon-craft Identifier (if applicable)
e. Instrument Identifier (if applicable)

OCC-DAT-00440 The OCC shall provide the capability to designate a type of event message as an alarm.

3.5 Monitor and Control Functions

This section contains the requirements associated with the real-time monitoring and controlling of the instruments and equipment included in or controlled by the OCC.

3.5.1 Resource Management

The Resource Management function provides the capability to manage and monitor the configuration of the OCC. It also is responsible for controlling and coordinating the necessary resources for telemetry monitoring and balloon-craft and instrument commanding. The Resource Management function receives requests from users for command authority. The OCC allows users to request the privilege to send commands to the instruments on the balloon-craft. The Resource Management function grants this privilege to authenticated users.

3.5.1.1 Resource Allocation

The Resource Allocation function provides the OCC user the capability to allocate resources to perform real-time telemetry and command processing and replay of historical telemetry. Elements of the OCC configuration may be altered to account for changes in the command set and/or telemetry parameters for a given mission.

OCC-RMC-01110 The OCC shall be capable of accepting operator requests to configure the OCC.

OCC-RMC-01120 The OCC shall allow operators to specify a version of the Project Data Base to use in processing data.

OCC-RMC-01130 The OCC shall provide the capability to accept configuration files that were created on the ROCC.

3.5.1.2 User Authorization

The User Authorization function ensures that only authorized users have the ability to command a ULDB balloon-craft. Users who wish to send commands to a balloon-craft must request command privilege. Once the request is received, the User Authorization software determines if the requesting user is an authorized user before the privilege is granted.

OCC-RMC-02110 The OCC shall provide the capability to authorize users, including OCC operators, PIs, and remote users, to command a ULDB balloon-craft.

OCC-RMC-02120 The OCC shall accept, validate, and process OCC operator requests to acquire the balloon-craft command privilege.

OCC-RMC-02130 The OCC shall provide a mechanism by which the command privilege of remote users can be disabled.

3.5.1.3 User Interface

The User Interface function is responsible for the human-machine interface for the OCC workstations. This includes displaying telemetry and providing commanding interfaces.

3.5.1.3.1 Screen Management

The OCC provides users the ability to manage their desktop environment.

OCC-RMC-13110 The OCC shall allow from 0 to 64 windows to be displayed simultaneously.

OCC-RMC-13120	The OCC shall provide the capability to define the default position and size of each window.
OCC-RMC-13130	The OCC shall provide the capability to define system defaults including printer and data directories.
OCC-RMC-13140	The OCC shall allow the user to perform typical windowing desktop control with the pointing device (mouse), including window movement, resizing, and closing.
OCC-RMC-13150	The OCC shall contain a command line area that allows the user to issue directives from a workstation keyboard.
OCC-RMC-13160	The OCC shall provide a command line editing capability that allows the retrieval and display of the 10 most recent input lines for modification and submission.
OCC-RMC-13170	The OCC shall provide an area that displays the 10 most recent event messages sent to the user.
OCC-RMC-13180	The OCC shall allow the user to initiate functions using function keys.

3.5.1.3.2 User Authentication

The OCC will provide security login procedures to authenticate OCC users.

OCC-RMC-23110	The OCC shall provide a login screen that allows a user to enter a user name and password.
OCC-RMC-23120	The OCC shall allow a user to specify a user type for the current login session.
OCC-RMC-23130	The OCC shall allow a user to have one or more user types.

3.5.1.3.3 Command Language

The OCC will implement a command language that users will employ to build procedures to support OCC operations. These operations include commanding, monitoring, and analysis of the balloon-craft and instruments and manipulating the user's workstation environment. Balloon-craft and instrument commanding will be governed by a script, which consists of time-stamped, time-ordered commands. The script can be augmented by the use of pre-planned procedures or individual commands that may be manually invoked by users with commanding authority. Local directives, which affect only the user's workstation (e.g., display a telemetry window, initialize the desktop, etc.) are also carried out via procedures that may be executed by all users. The following requirements define the command language functionality that will be used within the OCC to build commands and procedures.

OCC-RMC-33110	The OCC shall perform a syntax check of all commands entered by a user.
OCC-RMC-33120	The OCC shall notify the user of command syntax errors and display possible command options if part of the command string is recognized.

3.5.1.4 Procedure Builder

The OCC will provide the user with the capability to create, edit, store, print, and delete preplanned procedures. These procedures typically contain directives that are related to a single function (e.g., directives to safe and instrument). The OCC will provide standard editing capabilities coupled with OCC-specific capabilities such as procedure syntax checking and requests for command validation. A command

builder function will also be provided with the editor to assist the user in constructing directives. The command builder will present lists of valid directive components (e.g., directive keyword, mnemonic descriptors, etc.) that a user may select and insert into the procedure text. The following requirements define the procedure building capability that will be provided by the OCC. The term 'authorized user' indicated that the user must either be the owner (i.e. creator) of the procedure or have system administrator privileges.

OCC-RMC-04110 The OCC shall provide a user the capability to create, edit, and delete procedures.

OCC-RMC-04120 The OCC shall provide a user the capability to save procedures according to one of the following procedure types:
a. emergency
b. command
c. ground
d. local
e. activity
f. other user-defined category

OCC-RMC-04130 The OCC shall provide a user the capability to save a procedure according to a balloon ID.

OCC-RMC-04140 The OCC shall provide a user the capability to identify the author of each procedure.

OCC-RMC-04150 The OCC shall be capable of checking the syntax of a procedure.

OCC-RMC-04160 The OCC shall provide the user the capability to request validation of procedures. (Procedure validation will be performed by the Command Management function.)

OCC-RMC-04170 The OCC shall display a list of the following items that the user may select from to build procedures:
a. keywords
b. keyword qualifiers
c. mnemonics descriptors
d. mnemonic qualifiers
e. current limit values

OCC-RMC-04180 The OCC shall provide a user the capability to insert the following items into the procedure text:
a. keywords
b. keyword qualifiers
c. mnemonics descriptors
d. mnemonic qualifiers
e. limit identifiers
f. TBD logic capabilities (e.g., if, while, wait)

3.5.1.5 Reports

OCC-RMC-05110 The OCC shall have the capability to provide hardcopy and electronic versions of all off-line analysis displays for distribution as mission status reports.

OCC-RMC-05120 The OCC shall have the capability to provide a hardcopy of any of the currently displayed windows.

3.5.1.6 Utilities

3.5.1.6.1 Time Selection

The time selection utility will allow the user to specify a time, a pair of start and stop times, or a time interval. This utility will be used whenever the user needs to specify time values, such as with off-line analysis.

OCC-RMC-16110 The OCC shall allow the user to choose the start and stop time or an event and duration based on calendar date and time or the last N hours.

3.5.1.6.2 Selection Filter

OCC-RMC-26110 The OCC shall provide a utility that allows a user to filter items according to balloon-craft ID.

3.6 Data Analysis Functions

This section contains the requirements associated with the Analysis function. The OCC will provide analysis capabilities to maintain the health and safety of the ULDB balloon-craft and instruments. The analysis function will provide ULDB operations personnel with the tools necessary to perform balloon-craft systems management, performance analysis, trend analysis, fault detection, isolation, and recovery, and configuration management.

3.6.1 Data Access

All balloon-craft housekeeping telemetry data, statistical data generated by the OCC, and all operator-generated stored dataset files will be available as input to the analysis process.

OCC-ANL-00110 The OCC shall be able to access all archived balloon-craft telemetry data for analysis.

OCC-ANL-00120 The OCC shall be able to access all system generated statistics data files for analysis. (Note: System generated statistics may include such things as out of limits or configuration change information.)

OCC-ANL-00130 The OCC shall allow the operator to access a previously saved mission configuration dataset for analysis.

3.6.2 Data Base Usage

The OCC will store all valid databases and make these available for analysis of historical data.

OCC-ANL-00210 The OCC, by default, shall determine the appropriate data base to use for processing each request for data analysis.

OCC-ANL-00220 The OCC shall provide the capability to override the automatic data base selection by the system and process an analysis request using a data base specified by the user.

3.6.3 Analysis Utilities

The OCC will provide utilities for the analysis of data.

OCC-ANL-00310 The OCC shall be able to perform analysis on all balloon-craft telemetry parameters contained within the telemetry archive.

OCC-ANL-00320 The OCC shall notify the user of any mnemonic or other parameter information that has been requested for analysis and is found to be invalid for the specified mission or time interval requested.

OCC-ANL-00330 The OCC shall provide the capability to uniquely time tag parameters to the granularity of TBD milliseconds.

OCC-ANL-00340 The OCC shall provide the capability to build an off-line analysis request.

3.6.4 Analysis Product

A dataset is a collection of requested parameters, which is used to generate an analysis result such as a plot or report. Datasets are a standardized file that is used to produce the requested output, and can be stored and retrieved as needed.

OCC-ANL-00410 The OCC shall build a dataset in response to a request for data analysis.

OCC-ANL-00420 The OCC shall provide the capability to generate datasets which include any combination of one or more telemetry mnemonics.

OCC-ANL-00430 The OCC shall provide the capability to generate datasets based on telemetry start and stop times as specified in the request.

OCC-ANL-00440 The OCC shall provide the capability to generate datasets which contain telemetry values based on a user specified sampling rate specified per parameter.

OCC-ANL-00450 The OCC shall be able to build reports consisting of hardcopy or electronic file versions of analysis products.

OCC-ANL-00460 The OCC shall be able to display off-line analysis results in tabular and graphical views.

3.6.5 Statistics

The OCC will include tools that will calculate a basic set of statistical data on each telemetry parameter defined in the database.

OCC-ANL-00510 The OCC shall generate and store the following statistics for each telemetry mnemonic:

a. Minimum value
b. Balloon-craft time for the minimum value
c. Maximum value
d. Balloon-craft time for the maximum value
e. Mean
f. Standard Deviation
g. Number of samples

OCC-ANL-00520 The OCC shall compute and display statistics based on a user-supplied interval.

4.0 ROCC Requirements and Functional Specifications

Six functional areas have been defined to support ULDB operations. The defined functional areas may represent individual subsystems in the physical control center implementation, or may be combined into one or more physical subsystems. The functional areas are General Systems, Telemetry Acquisition, Command, Data Management, Real-time Monitor and Control, and Data Analysis.

4.1 General System Functions

This section specifies the ULDB mission requirements that are allocated to the Remote Operations Control Center. The operational and functional, integration and test, performance, external interface, security and hardware requirements will be included in this section.

4.1.1 Communication Interfaces

This section specifies the ROCC operational and functional requirements.

ROCC-GEN-00112 The ROCC shall use and support the TDRSS User RF Test Set (TURFTS) to obtain forward and return link data communications.

ROCC-GEN-00120 The ROCC shall use and support the INMARSAT network to obtain forward and return link data communications.

ROCC-GEN-00130 The ROCC shall use and support the Iridium network to obtain forward and return link data communications.

ROCC-GEN-00140 The ROCC shall use and support the ARGOS network to obtain return link data communications.

ROCC-GEN-00152 The ROCC shall use and support the local line of sight equipment (LOS) to obtain forward and return link data communications.

4.1.2 Integration and Test

ROCC-GEN-00210 The ROCC shall support instrument integration and test activities associated with the balloon-craft prior to launch.

4.1.3 Performance

System-level performance requirements are specified in this section, including capacities, capabilities, and throughput.

ROCC-GEN-00310 The ROCC shall relay a command from the user to the uplink interface within 1.0 second.

ROCC-GEN-00320 The ROCC shall support simultaneous monitoring and commanding of ULDB balloon-craft.

4.1.4 External Interfaces

ROCC external interfaces refer to the interfaces between the ROCC and various, supporting elements, NASA institutional facilities, and Principal Investigator (PI) sites.

ROCC-GEN-00410 The ROCC shall provide a near real-time interface to the PIs for forwarding of all science data and receipt of science instrument commands.

ROCC-GEN-00420 ROCC external interfaces shall conform to all security requirements specified in Section 4.1.5.

4.1.5 Security

This section specifies the overall ROCC security requirements.

ROCC-GEN-00510 The ROCC shall require unique sessions for each operator that accesses ROCC resources.

ROCC-GEN-00520 The ROCC shall require a unique user identification and password for each individual user.

ROCC-GEN-00530 The ROCC shall be able to perform filtering based on network address and/or TCP/IP socket number to control external interfaces.

ROCC-GEN-00540 The ROCC shall provide a secure means of receiving science payload data from PIs.

4.1.6 Hardware

This section defines the specification level requirements for the ROCC hardware. The ROCC will consist of one real-time server, one analysis server, and one fully configured backup server that is capable of providing all of the functionality of either the real-time or analysis server. An external interface server will act as the interface to local PIs for distribution of the science data.

4.1.6.1 Real-time Server

The ROCC will provide processors and peripheral equipment necessary for processing balloon-craft telemetry and commands.

ROCC-GEN-01610 The real-time server shall be physically and functionally identical to the analysis server and backup server.

ROCC-GEN-01620 The real-time server shall include a dedicated workstation to be used as the local systems operations console.

ROCC-GEN-01630 The real-time server shall be upgradeable/expandable with additional quantities and types of peripherals.

ROCC-GEN-01642 The real-time server disk drives shall provide a minimum of 5.4 GB of storage.

ROCC-GEN-01650 The real-time server shall support one CD-ROM drive.

4.1.6.2 Analysis Server

A user station will be provided to support ROCC analysis functions.

ROCC-GEN-02610 The analysis server shall conform to all real-time server requirements as stated in Section 4.1.6.1.

4.1.6.3 Backup Server

A backup server will be provided that may function as either the real-time server or analysis server in the event of a failure in either prime system.

ROCC-GEN-03610 The backup server shall conform to all real-time and analysis server requirements as stated in Sections 4.1.6.1 and 4.1.6.2, respectively.

4.1.6.4 External Interface Server

An external interface server will be provided to act as the interface to entities receiving data from or sending commands to any of the other ROCC servers.

ROCC-GEN-04610 A server shall be provided to act as the external interface to the ROCC.

4.1.6.5 Data Storage Unit

A data storage unit will be provided to store all incoming ULDB mission data.

ROCC-GEN-05612 The ROCC shall provide the capability to store a minimum of 5.4 GB of data per ULDB mission.

4.1.6.6 System Peripherals

The following peripheral devices will be supplied to support ROCC operations.

ROCC-GEN-06610 All ROCC real-time, analysis, and backup servers shall have monitors with a minimum diagonal measurement of 19 inches.

ROCC-GEN-06620 A shared system printer shall be provided that is accessible from the real-time, analysis, and backup servers.

4.2 Telemetry Acquisition Functions

The ROCC will provide the capability to receive, process, and monitor telemetry data from the balloon-craft. The real time telemetry function will accept CCSDS Transfer Frames (TBD), extract the CCSDS packets (TBD) from the transfer frames, and process those packets whose application identifiers are specified in the Project Data Base. All packets, regardless of application identifier, will be stored by the data storage function. Packets whose application identifiers indicate them to be science data or science housekeeping data will be forwarded without further processing to the instrument PI(s).

4.2.1 Telemetry Delivery

The ROCC will be able to receive and process telemetry from the balloon-craft and ROCC accessible telemetry archives.

4.2.1.1 Accept Telemetry Data

The ROCC will accept balloon-craft telemetry from multiple telemetry sources.

ROCC-TLM-01112 The ROCC shall be capable of receiving ULDB balloon-craft and instrument telemetry using the TURFTS.

ROCC-TLM-01120 The ROCC shall be capable of receiving ULDB balloon-craft and instrument telemetry using the INMARSAT communications service.

ROCC-TLM-01130 The ROCC shall be capable of receiving ULDB balloon-craft and instrument telemetry using ARGOS communications service.

ROCC-TLM-01140 The ROCC shall be capable of receiving ULDB balloon-craft and instrument telemetry using the Iridium communications service.

ROCC-TLM-01150 The ROCC shall be capable of receiving archived balloon-craft telemetry.

ROCC-TLM-01162 The ROCC shall be capable of receiving ULDB balloon-craft and instrument telemetry using LOS communications services.

4.2.1.2 Process CCSDS Transfer Frames

The ROCC will extract CCSDS standard source telemetry data packets from CCSDS Transfer Frames and distribute them for processing.

ROCC-TLM-02110 The ROCC shall accept CCSDS Transfer Frames containing balloon-craft and instrument telemetry data.

4.2.2 Telemetry Packet Processing

The ROCC will process CCSDS telemetry packets that have been extracted from transfer frames. The ROCC packet processing includes determining the proper sequence of the received packets and extracting the packet data fields required for further telemetry processing.

ROCC-TLM-00210 The ROCC shall accept a CCSDS Version-1 format.

ROCC-TLM-00220 The ROCC shall append a ground receipt date and time identifier to all received data.

ROCC-TLM-00230 Science instrument housekeeping and science telemetry data will be forwarded to the specified PI location.

ROCC-TLM-00240 The ROCC shall perform subsequent processing functions only balloon-craft housekeeping data.

Note: Subsequent requirements in this section refer to balloon-craft housekeeping data unless otherwise specified.

ROCC-TLM-00250 The ROCC shall examine the CCSDS packet sequence count located within the primary header to determine a proper packet sequence and to detect missing packets.

ROCC-TLM-00260 The ROCC shall process balloon-craft housekeeping telemetry based on predefined configuration-specific processing algorithms.

ROCC-TLM-00270 The ROCC shall be capable of continuously processing balloon-craft housekeeping telemetry at rates of at least 50 Kbps and up to 150 Kbps.

ROCC-TLM-00280 The ROCC shall provide for the conversion of balloon-craft housekeeping telemetry into Engineering Units (EUs).

ROCC-TLM-00290 The ROCC shall store all processed telemetry in TBD format indefinitely.

4.2.2.1 Limit Checking

The ROCC will have the capability of delta value checking any processed telemetry. A delta value is the maximum change expected between successive samples of a parameter. Delta values are defined in the telemetry database on an individual telemetry point basis.

The ROCC will also have the capability to apply range checking to analog and discrete parameters using up to four groups of red and yellow high/low limit values obtained from the telemetry data base. Range checking may be performed on raw or EU-converted values whenever range limits have been defined in the Project Data Base.

ROCC-TLM-01210 The ROCC shall perform high/low limit checking on parameters when limits have been defined.

ROCC-TLM-01220 The ROCC shall have the capability to limit check parameters for red high, red low, yellow high, and yellow low boundary violations.

ROCC-TLM-01230 The ROCC shall limit check telemetry data against its associated limit values for every occurrence of the parameter.

ROCC-TLM-01240 The ROCC shall compare the change of successive raw parameter values with the predefined delta value.

ROCC-TLM-01250 The ROCC shall mark each telemetry parameter indicating the current limit condition.

4.2.2.2 Limit Condition Reporting

A limit condition change notification is generated each time a parameter crosses a limit threshold value (when it exceeds a limit or when it comes back within a limit). A change in limit state may cause a notification to be output for display and/or logging. Notification is also provided during the time a parameter remains out of limits.

ROCC-TLM-02210 The ROCC shall notify the user when a parameter violates high/low limits.

ROCC-TLM-02220 The ROCC shall notify the user when a parameter returns to within high/low limits.

ROCC-TLM-02230 The ROCC shall notify the user when a parameter incurs a delta limit violation.

ROCC-TLM-02240 The ROCC shall generate a notification without an alarm for limit violations in the yellow range.

ROCC-TLM-02250 The ROCC shall generate a notification with an alarm for limit violations in the red range. Note: An alarm reflects the severity of the violation and may trigger the display of highlighted text, an audible alarm, or both.

ROCC-TLM-02260 The ROCC shall provide the capability of disabling (suppressing) or enabling notification messages concerning limits for all parameters. Note: Although the display of notification messages may be suppressed, they will continue to be stored or logged.

ROCC-TLM-02270 The ROCC shall provide the user the capability of changing limit values, delta limit values, and limit sense intervals. Note: Changing of the limit values via user directive is temporary. Permanent alterations may be accommodated through changes in the limit values resident within the Project Data Base.

4.2.2.3 Convert to Engineering Units

The ROCC provides the capability to convert processed telemetry data from raw counts EUs. Both raw and EU converted values will be accessible to the users.

ROCC-TLM-03210 The ROCC shall provide the capability for the user to select a predefined EU conversion algorithm.

ROCC-TLM-03220 The ROCC shall provide the capability for the user to adjust the predefined EU conversion algorithm coefficient values.

4.2.2.4 Access Processed Telemetry

The most recently processed value for each balloon-craft telemetry parameter is available for display and other application software access.

ROCC-TLM-04210 The ROCC shall make available the values for every predefined telemetry parameter.

ROCC-TLM-04220 The ROCC shall make available the status for every predefined telemetry parameter.

ROCC-TLM-04230 The ROCC shall make available, on a per-parameter basis, the following:
a. last processed raw value
b. associated converted value, if applicable
c. limit range values, if applicable
d. limit sense interval
e. no data available indicator
f. out of limits (low/high) indicators, if applicable
g. delta limit error indicator

4.2.2.5 Telemetry Displays

The ROCC will be capable of displaying all balloon-craft housekeeping and other parameters required to support ULDB operations.

ROCC-TLM-05210 The ROCC shall provide the capability to display all balloon-craft housekeeping parameters as defined in the Project Data Base.

ROCC-TLM-05220 The ROCC shall be capable of displaying telemetry data from the active communications source in a single telemetry window with a pull-down menu for selecting which data is displayed.

ROCC-TLM-05230 The ROCC shall provide one or more top-level engineering displays that will include the following parameters and parameter units:
a. GPS latitude
b. GPS longitude
c. GPS altitude (feet)
d. Number of GPS satellites
e. MKS High Sensor (Primary) (mBars)
f. MKS High Sensor (Backup) (mBars)
g. MKS Mid Sensor (Primary) (mBars)
h. MKS Mid Sensor (Backup) (mBars)
i. Auto-Ballast Total for Today (seconds)
j. Load Cell (lbs)
k. Cumulative Ballast Drop Total (lbs)
l. BUS A Power (watts)
m. BUS B Power (watts)
n. Battery A Voltage (volts)
o. Battery A Current (amps)
p. Battery B Voltage (volts)
q. Battery B Current (amps)
r. PV A Power (watts)
s. PV B Power (watts)
t. Cryocooler BUS Power (watts)
u. Cryocooler PV Power (watts)
v. Cryocooler Battery Voltage (volts)
w. Cryocooler Battery Current (amps)
x. INMARSAT Antenna Temp (TDRSS TM) (degrees C)
y. Primary Terminate Stack Temp (degrees C)
z. Backup Terminate Stack Temp (degrees C)
aa. Parachute Cutaway Stack Temp (degrees C)

bb. TOP Stack Temp (degrees C)
cc. Command Count
dd. Graphic of balloon position over time
ee. Graphic of balloon altitude over time
ff. Graphic of temperature over time
gg. TBD additional parameters

ROCC-TLM-05240 The ROCC shall provide additional displays that together display all balloon-craft housekeeping parameters.

ROCC-TLM-05250 The ROCC shall provide an operations display that is capable of displaying select science instrument housekeeping parameters.

ROCC-TLM-05260 The ROCC shall provide an operations display that will include the following parameters:
a. Current balloon position
b. Current balloon altitude
c. Current ambient temperature
d. Current balloon speed
e. Current balloon heading
f. TBD voltages
g. TBD currents
h. Communications link status
i. TBD additional parameters

4.2.2.6 Telemetry Store and Replay

The ROCC will have the capability of storing the down-linked raw telemetry. Stored telemetry may be processed by specifying the data type and start and (optionally) stop time. Replay operations simulate real-time telemetry processing, including limit and delta limit checking, and will likewise permit the generation of derived parameters.

ROCC-TLM-06210 The ROCC shall store telemetry data as received from the data source (e.g., TURFTS, INMARSAT, Iridium).

ROCC-TLM-06220 The ROCC shall be capable of receiving and storing real-time telemetry at rates of at least 50 Kbps and up to 150 Kbps.

ROCC-TLM-06230 The ROCC shall be capable of receiving and storing balloon-craft recorder playback telemetry at rates of at least 50 Kbps and up to 150 Kbps.

ROCC-TLM-06240 The ROCC shall be capable of accepting and storing the down-linked balloon-craft or instrument computer memory dump.

ROCC-TLM-06250 The ROCC shall be capable of replaying telemetry data based upon a user specified time period.

ROCC-TLM-06260 The ROCC shall process all balloon-craft housekeeping telemetry data for the requested period during the replay operation.

4.2.2.7 Telemetry Forwarding

The ROCC will have the capability to forward raw science data and raw science housekeeping data to PIs in near-real-time.

ROCC-TLM-07210 The ROCC shall provide an Ethernet interface capable of forwarding raw science data in near-real-time.

ROCC-TLM-07220 The ROCC shall provide an Ethernet interface capable of forwarding raw instrument housekeeping data in near-real-time.

ROCC-TLM-07230 The ROCC shall make available to PIs files containing processed balloon-craft housekeeping parameters for ftp pull.

4.3 Command Functions

The Command Function provides the capability to validate, build, up-link, and verify real-time commands for the ULDB balloon-craft and instruments. It provides up-link and verifies memory loads for the balloon-craft and instruments and verifies execution of stored commands for the balloon-craft and instruments during a real-time contact.

4.3.1 Command Scripting

The ROCC will provide tools used to manage the routine, planned operations of the ULDB missions. Planned operations are managed by means of scripts containing stored commands and/or data

ROCC-CMD-00110 The ROCC shall be capable of receiving, validating, and forwarding commands from an approved source. Approved sources may include the PI and one or more RMCS.

ROCC-CMD-00120 The ROCC shall provide the capability to create, edit, and delete a script consisting of one or more commands.

ROCC-CMD-00130 The ROCC shall validate each field of each real-time command in a procedure.

ROCC-CMD-00140 The ROCC shall provide the capability to display a listing of scripts that have been generated or executed during the previous seven days.

4.3.2 Command Transmission Configurations

The ROCC will have the capability to transmit commands to the ULDB balloon-craft and instruments using multiple interfaces.

ROCC-CMD-00212 The ROCC shall be capable of transmitting commands via the TURFTS.

ROCC-CMD-00220 The ROCC shall be capable of transmitting commands via the INMARSAT network.

ROCC-CMD-00230 The ROCC shall be capable of routing commands through the proper ocean region based on balloon location (GPS) when utilizing INMARSAT.

ROCC-CMD-00240 The ROCC shall be capable of transmitting commands via the Iridium network.

ROCC-CMD-00252 The ROCC shall be capable of transmitting commands via the LOS equipment.

4.3.3 Command Types

The ROCC will be capable of transmitting operator commands and command procedures.

ROCC-CMD-00310 The ROCC shall permit an authorized operator to issue individual commands in real-time.

ROCC-CMD-00320 The ROCC shall be capable of transmitting commands from a command procedure consisting of one or more commands.

ROCC-CMD-00330 The ROCC shall merge balloon-craft and instrument commands, and balloon-craft and instrument command procedures into one up-link stream.

4.3.4 Command Generation

ROCC-CMD-00410 The ROCC shall assemble standard, fixed-length packets from the command structures formatted for onboard execution.

ROCC-CMD-00420 The ROCC shall validate all real-time commands and ensure that the commands accepted conform to the command definition.

ROCC-CMD-00430 The command set shall be flight configurable.

4.3.5 Pre-transmission Validations

The ROCC will provide the capability to control the up-link of critical commands by requiring a second positive response from the operator. If a command procedure is being executed, authorization is required for each critical command to be up-linked.

ROCC-CMD-00510 The ROCC shall determine a specific command as critical based on its definition in the Project DataBase.

ROCC-CMD-00520 The ROCC shall require an operator authorization (allow or cancel) prior to up-linking a critical command, regardless of its origin (operator input or command procedure).

4.3.6 Command Authorization

ROCC-CMD-00610 The ROCC shall verify prior to acceptance of a command that the command was issued from a user with command authority.

ROCC-CMD-00620 The ROCC shall verify prior to acceptance of a command that the operator issuing the command has authorization for that specific command.

4.3.7 Command Transmission

ROCC-CMD-00710 The ROCC shall archive all up-linked information in the format transmitted by the ROCC.

ROCC-CMD-00720 The ROCC shall provide the capability to log each command based on the communications link through which it was sent.

ROCC-CMD-00730 The ROCC shall notify the operator when a command is transmitted.

ROCC-CMD-00740 The ROCC shall provide the capability to display the last command sent and a “button” to resend the last command sent, subject to additional operator authorization for critical commands.

ROCC-CMD-00750 Mission critical commands shall take precedence over all other commands. Mission critical commands for each mission are defined in the Project DataBase.

ROCC-CMD-00760 The ROCC shall provide an interface through which operations personnel can prevent the instrument PI(s) from using any of the command up-links.

ROCC-CMD-00770 The ROCC shall alert operations personnel when instrument PIs are utilizing a particular communications up-link.

ROCC-CMD-00780 The ROCC shall automatically append the associated balloon ID number to all commands (including science commands) to ensure that all commands are sent to the proper balloon in the event that the ROCC is supporting more than one concurrent mission.

4.3.8 Command Verification

Command receipt verification verifies that up-linked commands were received intact on board the balloon-craft.

ROCC-CMD-00810 The ROCC shall provide the capability to verify via COP-1 the successful receipt of real time commands by the balloon-craft.

ROCC-CMD-00820 The ROCC shall notify the operator of the status of each command up-linked as success or fail.

4.3.9 Command Displays

ROCC-CMD-00910 The ROCC shall be capable of displaying all commands as defined in the Project DataBase for each mission.

ROCC-CMD-00920 The ROCC shall display commands in a grouping according to command function.

ROCC-CMD-00930 The ROCC shall provide a macro facility (one command expanding to many) for frequently used sets of commands.

ROCC-CMD-00940 The ROCC shall display each command as it is selected.

ROCC-CMD-00950 Alerts for critical command functions may be visual (color, background changes) or audible.

4.4 Data Management Functions

The Data Management function is responsible for supporting ROCC mission operations, and is performed through four types of services: data base generation, file management, event processing, and ground telemetry generation.

4.4.1 Data Management

ROCC-DAT-00110 The ROCC shall display informational text messages about events that occur at the ROCC and on the balloon-craft.

ROCC-DAT-00120 The event display shall have a scrolling text field that displays the current event messages.

ROCC-DAT-00130 The ROCC shall provide the user with the capability to request and display event history data.

4.4.2 Project Data Base

The ROCC will provide a Project DataBase containing information necessary to support ROCC mission operations. Telemetry, command, and constraint definitions will be maintained within a PDB for each mission. The input definitions will be loaded into the mission PDB where they may be edited, validated,

and accessed for viewing. Once regarded as acceptable this information will be made available for operational use. The application software will use operational data to support telemetry processing and balloon-craft commanding.

4.4.2.1 PDB Inputs

The telemetry, command, and constraint definitions will be maintained within the PDB for each mission and will be used in support of ULDB mission operations.

ROCC-DAT-01210 The ROCC shall accept housekeeping telemetry definitions.

ROCC-DAT-01220 The telemetry definitions shall contain the following information:
a. Telemetry data processing definitions
b. Discrete telemetry definitions
c. Discrete state definitions
d. Analog telemetry definitions
e. Red/yellow and delta limit definitions
f. Engineering unit conversion definitions
g. Derived parameter definitions
h. Subsystem/instrument definitions

ROCC-DAT-01230 The ROCC shall accept balloon-craft and instrument command definitions

ROCC-DAT-01240 The command definitions shall contain the following information:
a. Balloon-craft command definitions
b. Instrument command definitions
c. Command criticality
d. Prerequisite state checking

4.4.2.2 PDB Edit

The ROCC will provide an edit capability to allow additions, deletions, and modifications of the definitions maintained in the PDB.

ROCC-DAT-02210 The ROCC shall provide authorized users the capability to add, delete, and modify telemetry definitions.

ROCC-DAT-02220 The ROCC shall provide authorized users the capability to add, delete, and modify command definitions.

ROCC-DAT-02230 The ROCC shall provide a PDB edit log presenting edits made to the PDB.

ROCC-DAT-02240 The ROCC edit log shall include the following information:
a. Time stamp
b. PDB version number
c. File name
d. User ID
e. Changes made to the PDB since the last update

4.4.2.3 PDB Validation and Reporting

The ROCC will provide validation of the definitions maintained in the PDB. Validation will include syntax checking, verification of values and cross-validation of related information.

ROCC-DAT-03210 The ROCC shall provide the capability to perform validation on the telemetry definitions maintained in the PDB.

ROCC-DAT-03220 The ROCC shall provide the capability to perform validation on the command definitions maintained in the PDB.

ROCC-DAT-03230 The ROCC shall provide the capability to perform validation on the constraint definitions maintained in the PDB.

ROCC-DAT-03240 The ROCC shall provide the capability to generate a validation report, which contains summary and error information.

ROCC-DAT-03250 The ROCC shall provide authorized users the capability to report information maintained in the PDB.

4.4.2.4 PDB Backup, Restore, and Compare

ROCC-DAT-04210 The ROCC shall maintain all versions of the operational PDB.

ROCC-DAT-04220 The ROCC shall maintain the following information for each version of the PDB:
a. PDB version number
b. Effective date

ROCC-DAT-04230 The ROCC shall provide the capability to backup the operational PDB.

ROCC-DAT-04240 The ROCC shall provide the capability to restore the operational PDB.

ROCC-DAT-04250 The ROCC shall provide the capability to compare two versions of the validated PDB.

4.4.3 File Management

The ROCC will provide the capability to archive and retrieve telemetry data, non-telemetry data, event data, and file data. All archived data will be maintained for a period of TBD days at the ROCC.

4.4.3.1 Telemetry Archive

The ROCC will provide the capability to archive and retrieve telemetry associated with each balloon-craft.

ROCC-DAT-01310 The ROCC shall archive all telemetry data.

ROCC-DAT-01320 The ROCC shall maintain the telemetry data on-line for a minimum of TBD days.

ROCC-DAT-01330 The ROCC shall provide the capability to retrieve archived data by specifying the following:
a. Balloon-craft start time
b. Balloon-craft stop time
c. Balloon-craft identifier
d. Data type

4.4.3.2 Events Archive

The ROCC will be capable of archiving and retrieving events associated with each balloon-craft.

ROCC-DAT-02310 The ROCC shall archive all event messages.

ROCC-DAT-02320 The ROCC shall provide the capability to retrieve archived events by specifying the following:

a. Start time
b. Stop time
c. Event type
d. Event identifier
e. Balloon-craft identifier
f. Instrument identifier (if applicable)

4.4.3.3 File Archive

The ROCC will be capable of storing, retrieving, and providing configuration control of data files in support of operations.

ROCC-DAT-03310 The ROCC shall be capable of storing and retrieving data files.

4.4.4 Event Message Processing

The ROCC will process and display all event messages. The event message will be formatted to include a time tag, event type, event identifier, event message, balloon-craft identifier (if applicable), and instrument identifier (if applicable). The ROCC provides the capability to set event filters, define event triggers, and toggle the alarm characteristic of an event.

ROCC-DAT-00410 The ROCC shall provide the capability to generate event messages.

ROCC-DAT-00420 The ROCC event messages shall include the following:
a. Time tag
b. Event type
c. Event identifier
d. Event message
e. Balloon-craft Identifier (if applicable)
f. Instrument Identifier (if applicable)

ROCC-DAT-00430 The ROCC shall provide the capability to filter event messages by:
a. Time tag
b. Event type
c. Event identifier
d. Balloon-craft Identifier (if applicable)
e. Instrument Identifier (if applicable)

ROCC-DAT-00440 The ROCC shall provide the capability to designate a type of event message as an alarm.

4.5 Monitor and Control Functions

This section contains the requirements associated with the real-time monitoring and controlling of the instruments and equipment included in or controlled by the ROCC.

4.5.1 Resource Management

The Resource Management function provides the capability to manage and monitor the configuration of the ROCC. It also is responsible for controlling and coordinating the necessary resources for telemetry monitoring and balloon-craft and instrument commanding. The Resource Management function receives requests from users for command authority. The ROCC allows users to request the privilege to send commands to the instruments on the balloon-craft. The Resource Management function grants this privilege to authenticated users.

4.5.1.1 Resource Allocation

The Resource Allocation function provides the ROCC user the capability to allocate resources to perform real-time telemetry and command processing and replay of historical telemetry. Elements of the ROCC configuration may be altered to account for changes in the command set and/or telemetry parameters for a given mission.

ROCC-RMC-01110	The ROCC shall be capable of accepting operator requests to configure the ROCC.
ROCC-RMC-01120	The ROCC shall allow operators to specify a version of the Project DataBase to use in processing data.
ROCC-RMC-01130	The ROCC shall provide the capability to accept configuration files that were created on the OCC.

4.5.1.2 User Authorization

The User Authorization function ensures that only authorized users have the ability to command a ULDB balloon-craft. Users who wish to send commands to a balloon-craft must request command privilege. Once the request is received, the User Authorization software determines if the requesting user is an authorized user before the privilege is granted.

ROCC-RMC-02110	The ROCC shall provide the capability to authorize users, including ROCC operators, PIs, and remote users, to command a ULDB balloon-craft.
ROCC-RMC-02120	The ROCC shall accept, validate, and process ROCC operator requests to acquire the balloon-craft command privilege.
ROCC-RMC-02130	The ROCC shall provide a mechanism by which the command privilege of remote users can be disabled.

4.5.1.3 User Interface

The ROCC provides users the ability to manage their desktop environment.

4.5.1.3.1 Screen Management

The ROCC provides users the ability to manage their desktop environment.

ROCC-RMC-13110	The ROCC shall allow from 0 to 64 windows to be displayed simultaneously.
ROCC-RMC-13120	The ROCC shall provide the capability to define the default position and size of each window.
ROCC-RMC-13130	The ROCC shall provide the capability to define system defaults including printer and data directories.
ROCC-RMC-13140	The ROCC shall allow the user to perform typical windowing desktop control with the pointing device (mouse), including window movement, resizing, and closing.
ROCC-RMC-13150	The ROCC shall contain a command line area that allows the user to issue directives from a workstation keyboard.

ROCC-RMC-13160 The ROCC shall provide a command line editing capability that allows the retrieval and display of the 10 most recent input lines for modification and submission.

ROCC-RMC-13170 The ROCC shall provide an area that displays the 10 most recent event messages sent to the user.

ROCC-RMC-13180 The ROCC shall allow the user to initiate functions using function keys.

4.5.1.3.2 User Authentication

The ROCC will provide security login procedures to authenticate ROCC users.

ROCC-RMC-23110 The ROCC shall provide a login screen that allows a user to enter a user name and password.

ROCC-RMC-23120 The ROCC shall allow a user to specify a user type for the current login session.

ROCC-RMC-23130 The ROCC shall allow a user to have one or more user types.

4.5.1.3.3 Command Language

The ROCC will implement a command language that users will employ to build procedures to support ROCC operations. These operations include commanding, monitoring, and analysis of the balloon-craft and instruments and manipulating the user's workstation environment. Balloon-craft and instrument commanding will be governed by a script, which consists of time-stamped, time-ordered commands. The script can be augmented by the use of pre-planned procedures or individual commands that may be manually invoked by users with commanding authority. Local directives, which affect only the user's workstation (e.g., display a telemetry window, initialize the desktop, etc.) are also carried out via procedures that may be executed by all users. The following requirements define the command language functionality that will be used within the ROCC to build commands and procedures.

ROCC-RMC-33110 The ROCC shall perform a syntax check of all commands entered by a user.

ROCC-RMC-33120 The ROCC shall notify the user of command syntax errors and display possible command options if part of the command string is recognized.

4.5.1.4 Procedure Builder

The ROCC will provide the user with the capability to create, edit, store, print, and delete preplanned procedures. These procedures typically contain directives that are related to a single function (e.g., directives to safe and instrument). The ROCC will provide standard editing capabilities coupled with ROCC-specific capabilities such as procedure syntax checking and requests for command validation. A command builder function will also be provided with the editor to assist the user in constructing directives. The command builder will present lists of valid directive components (e.g. directive keyword, mnemonic descriptors, etc.) that a user may select and insert into the procedure text. The following requirements define the procedure building capability that will be provided by the ROCC. The term 'authorized user' indicated that the user must either be the owner (i.e. creator) of the procedure or have system administrator privileges.

ROCC-RMC-04110 The ROCC shall provide a user the capability to create, edit, and delete procedures.

ROCC-RMC-04120 The ROCC shall provide a user the capability to save procedures according to one of the following procedure types:
a. emergency
b. command

c. ground
d. local
e. activity
f. other user-defined category

ROCC-RMC-04130 The ROCC shall provide a user the capability to save a procedure according to a balloon ID.

ROCC-RMC-04140 The ROCC shall provide a user the capability to identify the author of each procedure.

ROCC-RMC-04150 The ROCC shall be capable of checking the syntax of a procedure.

ROCC-RMC-04160 The ROCC shall provide the user the capability to request validation of procedures. (Procedure validation will be performed by the Command Management function.)

ROCC-RMC-04170 The ROCC shall display a list of the following items that the user may select from to build procedure:
a. keywords
b. keyword qualifiers
c. mnemonics descriptors
d. mnemonic qualifiers
e. current limit values

ROCC-RMC-04180 The ROCC shall provide a user the capability to insert the following items into the procedure text:
a. keywords
b. keyword qualifiers
c. mnemonics descriptors
d. mnemonic qualifiers
e. limit identifiers
f. TBD logic capabilities (e.g. if, while, wait)

4.5.1.5 Reports

ROCC-RMC-05110 The ROCC shall have the capability to provide hardcopy and electronic versions of all off-line analysis displays for distribution as mission status reports.

ROCC-RMC-05120 The ROCC shall have the capability to provide a hardcopy of any of the currently displayed windows.

4.5.1.6 Utilities

4.5.1.6.1 Time Selection

The time selection utility will allow the user to specify a time, a pair of start and stop times, or a time interval. This utility will be used whenever the user needs to specify time values, such as with off-line analysis.

ROCC-RMC-16110 The ROCC shall allow the user to choose the start and stop time or an event and duration based on calendar date and time or the last N hours.

4.5.1.6.2 Selection Filter

ROCC-RMC-26110 The ROCC shall provide a utility that allows a user to filter items according to balloon-craft ID.

4.6 Data Analysis Functions

This section contains the requirements associated with the Analysis function. The ROCC will provide analysis capabilities to maintain the health and safety of the ULDB balloon-craft and instruments. The analysis function will provide ULDB operations personnel with the tools necessary to perform balloon-craft systems management, performance analysis, trend analysis, fault detection, isolation, and recovery, and configuration management.

4.6.1 Data Access

All balloon-craft housekeeping telemetry data, statistical data generated by the ROCC, and all operator-generated stored dataset files will be available as input to the analysis process.

ROCC-ANL-00110 The ROCC shall be able to access all archived balloon-craft telemetry data for analysis.

ROCC-ANL-00120 The ROCC shall be able to access all system generated statistics data files for analysis. (Note: System generated statistics may include such things as out of limits or configuration change information.)

ROCC-ANL-00130 The ROCC shall allow the operator to access a previously saved mission configuration dataset for analysis.

4.6.2 Data Base Usage

The ROCC will store all valid databases and make these available for analysis of historical data.

ROCC-ANL-00210 The ROCC, by default, shall determine the appropriate database to use for processing each request for data analysis.

ROCC-ANL-00220 The ROCC shall provide the capability to override the automatic data base selection by the system and process an analysis request using a data base specified by the user.

4.6.3 Analysis Requests

The ROCC will provide the capability to process requests for the analysis of data. During the processing of the request the ROCC will notify the user of any errors or discrepancies in the user-supplied information.

ROCC-ANL-00310 The ROCC shall be able to perform analysis on all balloon-craft telemetry parameters contained within the telemetry archive.

ROCC-ANL-00320 The ROCC shall notify the user of any mnemonic or other parameter information that has been requested for analysis and is found to be invalid for the specified mission or time interval requested.

ROCC-ANL-00330 The ROCC shall provide the capability to uniquely time tag parameters to the granularity of TBD milliseconds.

ROCC-ANL-00340 The ROCC shall provide the capability to build an off-line analysis request.

4.6.4 Analysis Products

A dataset is a collection of requested parameters, which is used to generate an analysis result such as a plot or report. Datasets are a standardized file that is used to produce the requested output, and can be stored and retrieved as needed.

ROCC-ANL-00410 The ROCC shall build a dataset in response to a request for data analysis.

ROCC-ANL-00420 The ROCC shall provide the capability to generate datasets that include any combination of one or more telemetry mnemonics.

ROCC-ANL-00430 The ROCC shall provide the capability to generate datasets based on telemetry start and stop times as specified in the request.

ROCC-ANL-00440 The ROCC shall provide the capability to generate datasets that contain telemetry values based on a user specified sampling rate specified per parameter.

ROCC-ANL-00450 The ROCC shall be able to build reports consisting of hardcopy or electronic file versions of analysis products.

ROCC-ANL-00460 The ROCC shall be able to display off-line analysis results in tabular and graphical views.

4.6.5 Statistics

The ROCC will automatically calculate a basic set of statistical data on each telemetry parameter defined in the database.

ROCC-ANL-00510 The ROCC shall generate and store the following statistics for each telemetry mnemonic:

a. Minimum value
b. Balloon-craft time for the minimum value
c. Maximum value
d. Balloon-craft time for the maximum value
e. Mean
f. Standard Deviation
g. Number of samples

ROCC-ANL-00520 The ROCC shall compute and display statistics based on a user-supplied interval.

5.0 RMCS Requirements and Functional Specifications

The RMCS will provide limited monitor and control capability for remote ULDB scientists and engineers.

5.1 General System Functions

This section specifies the ULDB mission requirements that are allocated to the Remote Monitoring and Control System(s). The OCC interface and security will be included in this section.

5.1.1 OCC Interfaces

RMCS-GEN-00110 The RMCS shall communicate commands to and receive data from the OCC via the Internet.

5.1.2 Security

This section specifies the overall RMCS security requirements.

RMCS-GEN-00210 Access by the RMCS to the OCC shall be limited to a set of registered list of users.

RMCS-GEN-00220 The RMCS shall require a unique user identification and password for each individual user.

RMCS-GEN-00230 The RMCS shall provide a secure means of receiving data.

5.2 Remote Telemetry Data Monitoring Functions

This section specifies the RMCS remote data monitoring requirements.

RMCS-TLM-00010 The RMCS shall provide one or more top-level 'operations' displays that will include the following parameters and parameter units:

a. GPS latitude
b. GPS longitude
c. GPS altitude (feet)
d. Graphic of balloon position over time
e. Graphic of balloon altitude over time
f. Graphic of temperature over time
g. TBD additional parameters

RMCS-TLM-00020 The RMCS shall provide an engineering display that will include the following parameters:

a. Current balloon position
b. Current balloon altitude
c. Current ambient temperature
d. Current balloon speed
e. TBD voltages
f. TBD currents
g. Communications link status
h. TBD additional parameters

5.3 Remote Command Forwarding Functions

This section specifies the RMCS remote command forwarding requirements.

RMCS-CMD-00010 The RMCS shall permit an authorized operator to issue individual commands in real-time.

RMCS-CMD-00020 The RMCS shall be capable of issuing commands from a command procedure consisting of one or more commands.

RMCS-CMD-00030 The RMCS shall forward all commands to the OCC for formatting, verification, and up-link.

RMCS-CMD-00040 The RMCS shall lose its command privilege automatically after TBD minutes of inactivity.

6.0 References

The following documents are considered reference materials with have relevancy to this document.

NASA Systems Engineering Handbook SP-6105

Manager's Handbook for Software Development NASA ID: SEL-84-101

Ultra Long Duration Balloon (ULDB) Program Study: Interim Report (Polidan Study): http://lheawww.gsfc.nasa.gov/docs/balloon/ULDB_study/DAYBAL_4.html

Acronyms

EU	Engineering Unit
GB	Gigabyte
GPS	Global Positioning System
IRIG	Inter-range instrumentation group
Kbps	Kilobits per second
LDB	Long Duration Balloon
LOS	Line of sight
MPT	Mission planning terminal
OCC	Operations Control Center
PCM	Pulse Code Modulation
PDB	Project data base
PI	Principal Investigator
RMCS	Remote Monitor and Control System
ROCC	Remote Operations Control Center
SN	Space Network
TBD	To be determined
TCP/IP	Transmission Control Protocol/Internet Protocol
TDRSS	Tracking and Data Relay Satellite System
TURFTS	TDRSS User RF Test Set
ULDB	Ultra Long Duration Balloon